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ABSTRACT

A growing interest among industrial and organizational psychologists is learning how to predict and maximize trainability. This study was conducted to examine the relationship between dimensions of cognitive style and perceptual mode as well as their association with a learning style instrument, explore the relationship between field independence/dependence and Type A behavior, and investigate trainability as a match between perceptual mode and instructional method. College students and young professionals (N=120) completed measures assessing cognitive style, learning style, intelligence, and Type A behavior. It was hypothesized that subjects who used a visual perceptual mode would be more field independent, reflective, and more intelligent than those who used a haptic mode. Eighty-one subjects performed a haptic task in which the method of instruction was varied. It was expected that when a visual or haptic perceptual mode was matched with an equivalent method of instruction, trainability would be maximized. While no relationship between perceptual mode and cognitive style dimensions nor method of instruction emerged, it was found that cognitive style dimensions fell into two categories: a speed/error factor and an ability group. It was also discovered that trainability could be maximized by matching dimensions of cognitive style, not perceptual mode, with a method of instruction. The relationships between cognitive style dimensions, with both Type A behavior and a learing style instrument, were also explored, revealing one significant relationship. (Appendixes include a set of diagnosis for visual instruction in origami folding art, tables of performance measures, and a word association tabulated by words elicited.) (Author/NB)

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Dimensions of Cognitive Style
Their Interrelationships and Use in Maximizing Trainability

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Abstract

Cognitive style is acknowledged here as one subset of learning style (Keefe, 1979). The relationship between perceptual mode (visual/haptic) and cognitive style dimensions was explored first. 120 subjects filled out a battery of measures to assess dimensions of their cognitive style, learning style, level of intelligence and Type A behavior. It was hypothesized that visuals would be more field independent, reflective, and more intelligent than their haptic counterparts. Subsequently, trainability was studied as a match between perceptual mode and method of instruction. Eighty-one subjects performed a haptic task in which the method of instruction used was varied. It was expected that when perceptual mode (visual/haptic) was matched with an equivalent method of instruction (visual/haptic), trainability would be maximized. While no relationship between perceptual mode and cognitive style dimensions nor method of instruction (trainability) emerged, it was found that cognitive style dimensions fall into two categories: a speed/error factor and an ability group. It was also discovered that trainability can be maximized by matching dimensions of cognitive style, not perceptual mode, with a method of instruction. The relationships between cognitive style dimensions, with both Type A behavior and a learning style instrument were also explored. One significant relationship emerged.

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Dimensions of Cognitive Style: Their Interrelationships and Use in Maximizing Trainability

A growing interest among Industrial/Organizational Psychologists is learning how to predict and maximize trainability. Trainability refers to a person's ability to acquire the skills, knowledge or behavior necessary to perform a job at a given level (Robertson & Downs, 1979). Wexley and Latham (1981; Maier, 1973) assert that trainability is a function of an individual's ability and motivation. The authors claim that both ability and motivation must exist for performance to occur.

In his review article, Wexley (1984) noted that trainability research has focused predominantly on ability ('can do') factors; few studies have been done on motivation ('will do') factors. Studies completed thus far have studied the constructs separately.

Researchers (Wexley, 1984; Terborg, 1981) are currently asserting that trainability should be studied as an interaction between person and situation variables. Person variables are such things as ability, motivation and cognitive style. Instructional methods and tasks administered during training are two types of situation variables studied to date.

In this study, cognitive style will be the person variable examined. It is asserted here that in order to maximize and begin predicting trainability, researchers should study dimensions of an individual's cognitive style as the "person" variables, instructional method and task as

the "situation" variables and then maximize the 'fit' between all three.

The following topics are covered in this introduction. First, the constructs of learning style and cognitive style are discussed. The literature on learning style and cognitive style has been confusing due to the misuse of terms (e.g., Hess & Sperry, 1976). This discussion intends to clarify any confusion that exists. A discussion of the dimensions of cognitive style and perceptual mode as well as the relationship between them is reviewed. The relationship between cognitive style and learning style is presented next. The researcher supports the view that cognitive style is one part of learning style. A discussion of the learning style inventories used to measure learning style follows. Subsequently, the research that has focused on fitting instructional methods to cognitive styles is presented.

Components of Learning Style

Learning style is a term often used interchangeably with cognitive style in the literature (Worthley, 1987; Ausburn, L.J., 1979). The definition of learning style most often cited, states that learning style refers to an individual's personal/preferred way of perceiving, thinking, problem-solving and remembering in learning situations (Hess & Sperry, 1973; Worthley, 1987). Messick (1976) defined cognitive style as information processing habits representing the learner's typical way of perceiving, thinking, problem solving and remembering.

To clarify the distinction, Keefe (1979) asserted that learning style is a broader term which includes cognitive, affective, and physiological styles. Keefe (1979) defines learning style as: "characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (p.4). The distinction that cognitive style is a subset of learning style is used in the remainder of this paper.

Investigators (Keefe, 1979; Kagan, 1971; Ausburn, L.J., 1979) working in this research domain, make it a point to differentiate between styles and abilities. Cognitive style is not an ability (Ausburn, L.J., 1979). Kagan (1971) claims that abilities concern a level of skill - the more and less of performance. Styles on the other hand, illustrate the process of cognition; they tell how information is being processed (Keefe, 1979; Kagan, 1971).

Santostefano (1988) differentiates other researchers' (e.g., Kagan, 1971) views of cognitive style from his own. It appears that the cognitive style models of other researchers use single, broad cognitive principles to account for individual differences (cited in Santostefano, 1988). In contrast, Santostefano supports a cognitive control theory of cognitive style. In cognitive control theory, a pattern of cognitive controls is defined as a cognitive style. These patterns characterize the various strategies a person uses to manage, control, and regulate information. Santostefano believes psychologists should be

analyzing how different cognitive mechanisms work in synchrony for the individual rather than one main mechanism, as the other cognitive style researchers assert.

Perceptual Mode

Lowenfeld (1945) identified two distinct perceptual types (visual and haptic), who have two dissimilar manners of perceiving and reacting to the world of experience (Ausburn, L.J., 1979). According to L.J. Ausburn, Lowenfeld's visual type uses his/her eyes as the main intermediary of sensory impressions and acts as an observer, approaching things from their appearance and feeling as a spectator. The visual type can and does transform kinesthetic and tactile experiences into visual ones. The main intermediary for the haptic individual is the 'body-self' - the muscular sensations, kinesthetic experiences, touch impressions, and other physical sensations. They do not transform kinesthetic and tactile experiences into visual ones. They use their eyes as the primary sensory intermediary only when compelled to do so.

Lowenfeld through his extensive work, found that most populations exhibit the following distribution of perceptual types: visual: 50%, indefinite: 25%, and haptic: 25%. L.J. Ausburn (1979) discussed many of the differences between visuals and haptics. The most important difference is that while the visual has the ability to see a whole, break it up and see its component details and then to resynthesize the details back into a whole, the haptic is unable to do this. It would appear

therefore that visual types tend to be more analytic and haptics tend to be global. Some researchers claim that perceptual mode is related to cognitive style (F.B. Ausburn, 1979) yet others (Dunn, Dunn, & Price, 1979) assert it is a dimension of physiological style. Perceptual mode will be kept separate from the other dimensions of cognitive style since it is not clear which style it is related to.

Dimensions of Cognitive Style

Messick (1976) listed twenty dimensions of cognitive style. Of the twenty dimensions listed, Keefe (1979) states that field independence/dependence, conceptual tempo, leveling/sharpening, and perceptual mode have the greatest implications for improving the learning process due to their conceptual importance or practical utility. A discussion of the first three dimensions follows. The research conducted on cognitive style has focused predominantly on these dimensions. Perceptual mode was discussed above.

Field Independence/Dependence

Field Independence/dependence was the first developed and has been the most thoroughly investigated component of cognitive style (Keefe, 1979; Worthley, 1987). Field independence/dependence is a perceptual dimension anchored at the extremes by two types of visual perception: (1) perception which is heavily influenced by field factors and the complexity of background versus (2) perception which is only slightly influenced by these factors. Differentiation

refers to the complexity of a system's structure (Worthley, 1987). The most prominent investigator in the area of differentiation is Witkin (Witkin et al., 1977). Witkin found that some individuals used perceptual cues to perceive the upright (vertical objects), but others relied on haptic cues (Santostefano, 1988). The field dependent person differs from the field independent person in many ways, each relating to how differentiated the individual is (Worthley, 1987).

Chickering (cited in Worthley, 1987) states that analytic ability is the fundamental difference between field independent and field dependent individuals. Worthley's (1987) results support this notion suggesting that field independent people use analytic problem solving strategies whereas field dependent individuals use those that are more global. According to Worthley, where a problem-solving strategy refers to the specific, non-enduring manner in which an individual approaches a problematic task in order to find a solution, analytic problem solving strategies refer to those in which the individual uses skills such as data analysis, breaking the problem into sub-problems and inductive reasoning. Global problem solving strategies refer to those in which the individual uses skills such as synthesis, imaging, trial and error, and deductive reasoning.

Field Independence/Dependence and Type A Behavior.

The literature reviewed thus far reveal some similarities between field independence/dependence and

personality dimensions (e.g., Type A behavior). Ramirez and Castaneda (cited in Worthley, 1987) stated that the field independent student prefers to compete and gain individual recognition, is often task oriented, tends to be impatient to begin tasks, and prefers learning that emphasizes the details of concepts. Furthermore, Chickering (cited in Worthley, 1987) asserted that the field dependent person relies heavily on external sources (e.g., a teacher, another student) to create discontinuity, and to make details more evident in the ground in order for differentiation to occur. Type A individuals seem to share some of these characteristics. Type A individuals are excessively hard-driving and competitive, impatient and time-urgent, and easily aroused to anger and hostility when confronted with persons or things that hinder their attempts to achieve. Type B behavior has been traditionally defined by the relative absence of Type A characteristics (Strube, 1987).

The Self-Appraisal Model of Type A Behavior (Strube, Boland, Manfredo, and Al-Falaij, 1987), is based on the premise that Type As and Bs differ in their desire to appraise their abilities accurately. Type As have a greater concern than Type Bs for accurate appraisal of their abilities because such appraisal is necessary to attain goals. Type As exhibit self-appraisal behaviors as responses to situational factors that increase uncertainty about one's capabilities. Type As seek out a comparison

other of an ability level equal to or better than their own in order to evaluate their own performance.

The constructs of field independence/dependence and Type A behavior share different attributes. Field independent and Type A individuals appear to be task-oriented and impatient. On the other hand, Type As and field dependent individuals seem to seek out external sources to evaluate or simplify their own performance. Type As might therefore be more similar to field dependent people due to their desire to seek out comparison others. Type A behavior is just one example of a personality variable which might interact with dimensions of one's cognitive style to affect performance. Therefore, the relationship between the two will be studied here.

Conceptual/Cognitive Tempo

The second dimension is reflectivity/impulsivity or what is called 'conceptual/cognitive tempo' (Ausburn, L.J., 1979; Hess & Sperry, 1973). Conceptual tempo or "reflection/impulsivity" was developed by Kagan (cited in Santostefano, 1988). According to L.J. Ausburn (1979), cognitive tempo is concerned with the speed with which hypotheses are selected and information processed. Hess and Sperry (1973) claim that tempo refers to one's evaluation of his/her own intellectual product, and one's willingness to pause and reflect on the accuracy of his/her hypotheses and solutions. When given several response possibilities simultaneously, the impulsive person reports the first hypothesis that comes to him/her and is usually

incorrect. The reflective individual considers all possibilities before responding and is usually correct. Originally, Kagan (1969) developed the Matching Familiar Figures Test (MFFT) to assess a child's level of impulsivity/reflectivity. He later developed a more difficult version for adults. According to Hess and Sperry (1973), reflective learners tend to be analytic in their thinking. The analytic learner tends to know details when exposed to a complex problem or situation, while the thematic (global) or more impulsive learner responds to the situation or to the problem as a whole.

As stated earlier, Kagan asserted that cognitive style is not an ability. However, after correlating performance on a picture-sorting task with performance in various test situations, Kagan found that those with an analytic style achieved higher I.Q.s which could be considered mental ability. It would be interesting therefore to study the relationship between dimensions of cognitive style (e.g., field independence/dependence) and mental ability to see if cognitive style is tapping abilities in any manner.

Leveling/Sharpening

Santostefano (1978) researched the area of leveling/sharpening, which deals with how individuals manage information that remains stable or changes over time. Leveling/sharpening defines the manner in which an individual compares past information with perceptions of present information (Santostefano, 1988). It deals with individual variations in memory processing (Keefe, 1979).

According to L.J. Ausburn (1979), levelers merge new experiences with memories of earlier ones and therefore construct relatively undifferentiated memories of ongoing experiences. They tend to overgeneralize (Keefe, 1979). Sharpeners tend to maintain discrete impressions and memories of sequentially presented stimuli so that elements do not loose their individuality (Ausburn, L.J., 1979). They tend to overdiscriminate (Keefe, 1979).

Perceptual Mode and Dimensions of Cognitive Style

F.B. Ausburn (1979) investigated the relationship between the cognitive style factors of field independence/dependence, reflectivity/impulsivity, leveling/sharpening, and their relationship to the two types of perceptual modes. His results conclude that perceptual mode is related to the dimensions of cognitive style. When working on a visual task (e.g., watching different films and recognizing when a change has occurred), visuals tend to display field independence, reflectivity and sharpening in their cognitive styles, while haptics tend to display field dependence, impulsivity, and leveling tendencies. It would be interesting to see if the same relationship between the dimensions would emerge if subjects were asked to perform a haptic task. According to F.B. Ausburn (1979), each of the cognitive style dimensions discussed can independently predict perceptual mode, yet field independence/dependence and the number of errors made on the MFFT were the best predictors of perceptual mode and correlated most with

cognitive style. The latency component of the MFFT was not related to perceptual mode.

A factor analysis of the variables involved in a study conducted by L.J. Ausburn (1979) revealed that the trait of leveling/sharpening might be more closely related to memory recall, rather than perceptual mode. L.J. Ausburn (1979) calls for a replication of her study in order to determine the generalizability of results.

Affective Style

Affective learning style refers to motivational processes viewed as the learner's typical way of arousing, directing and sustaining behavior (Keefe, 1979). According to Keefe, the affective dimension of learning style encompasses the dimensions of personality that deal with attention, emotion and valuing. Keefe notes that like cognitive style, affective style is a hypothetical construct which can only be inferred from a person's interaction with the environment.

Keefe briefly discussed the dimensions of affective style. Based upon the research reported thus far, locus of control, conceptual level, achievement motivation, and social motivation, have the greatest implication for improving the learning process. For the purpose of this study, these dimensions do not need to be defined here.

Physiological Style

Finally according to Keefe (1979), physiological styles are biologically-based modes of responses that are founded on sex-related differences, personal nutrition and

health, and accustomed reaction to the physical environment. The dimensions included here are: masculine-feminine behavior, health-related behavior, time rhythms, need for mobility and environmental elements. It was presented earlier that perceptual mode is a dimension of cognitive style (Keefe, 1979) yet some researchers claim it is a 'physical' element of learning style (Dunn, Dunn, & Price, 1979). Whether perceptual mode is a dimension of cognitive style or physiological style needs to be clarified.

Learning Style Inventories

The question that remains unanswered is whether the learning style inventories are measuring all of the dimensions of learning style or only some of them (e.g., cognitive style). Keefe (1979) as discussed earlier, conceptualized learning style as composed of three styles: cognitive, affective, and physiological/physical. Ferrell (1983) factor analyzed four learning style inventories which were developed based on Keefe's conceptualization. The four instruments used were the: Grasha-Reichmann Student Learning Style Scales (SLSS) (Reichmann & Grasha, 1974), the Kolb Learning Style Inventory (Kolb LSI) (Kolb, 1976), the Dunn Learning Style Inventory (Dunn LSI) (Dunn, Dunn & Price, 1975) and the Coscarelli's Johnson Decision Making Inventory (DMI), (cited in Ferrell, 1983). The learning style inventories tend to emphasize one or two of these styles, but not all three. Results suggest that the Kolb LSI and the DMI assess purely cognitive dimensions,

the SLSS assesses cognitive and affective ones and the Dunn LSI assesses those that are physiological and affective.

The Kolb LSI used in Ferrell's study is the 1976 version. The Kolb LSI was revised in 1985. In the 1976 version, nine sets of four words are rank ordered by the subject. Two sets of bipolar dimensions are assessed: **Concrete Experience** versus **Abstract Conceptualization**, and **Active Experimentation** versus **Reflective Observation**. The results of Ferrell's (1983) factor analysis found that the Kolb LSI was the only instrument of the four studied for which a match between the factors identified and the supportive theory was found; the Kolb LSI supported Kolb's conceptualization of learning style. Similarly, Katz (1986) administered the 1976 version to students at the Hebrew University of Jerusalem. The emergent factor structure supported Kolb's two bipolar dimensions of learning.

The Kolb LSI however, has encountered serious attack due to its low test-retest reliability (e.g., .30-.71) and poor construct validity (Wexley, 1984). Freedman and Stumpf (1980) claim that a factor analysis they performed, provided weak support for Kolb's two bipolar dimensions. Despite the question concerning the reliability of the measure, it is asserted here that the Kolb LSI is assessing cognitive dimensions, not physiological or affective. Therefore it should be considered a cognitive style instrument rather than a learning style measure.

Matching Cognitive Styles to Instructional Methods

Most of the research on matching instructional methods to cognitive styles has been completed on student populations (Neumann, Barton & Critelli, 1979), particularly those who have difficulty in learning (e.g., Worthley, 1987). Most researchers working in this domain try to match some aspect of student learning style (i.e., conceptual level, field independence/dependence, physiological characteristics of the environment) with the teacher's style (Hunt, 1979; Anderson & Bruce, 1979). According to Gregorc (1979), teaching style consists of a teacher's personal behaviors and the media used to transmit data to or receive from the learner.

In the past decade or two, psychologists have begun applying these principles to adult populations (Ausburn, F. B., 1979). Moreover, a handful of researchers (e.g., Mezoff, 1982; Hall & Freda, 1982) have recognized the significance of applying the interaction between person characteristics and the environment to training situations. Most of this work has focused on cognitive style (e.g., Hess & Sperry, 1973; L.J. Ausburn, 1979).

Hess and Sperry's article (1973) was one of the first to discuss the implications of matching cognitive style (which they labelled learning style) with instructional method in training. They claim that cognitive style is composed of perceptual mode, reflectivity/impulsivity, analytic/global thinking, and field independence/dependence. They made no mention of the

affective or physiological styles nor the leveling/ sharpening dimension of cognitive style. They were clearly relating training method to cognitive style, not learning style. Unfortunately, Hess and Sperry cited no references or research in their article.

Based upon the research reviewed thus far, there seem to be two approaches that researchers use when pairing cognitive style with instructional method (e.g., Ausburn, F.B., 1979; Hess & Sperry, 1973). Most researchers tend to use instructional methods that match one's cognitive style (e.g., visual perceptual mode with visual presentation method) (Mezoff, 1982; McCombs, 1979). I am calling this the 'matching approach'. Yet, another approach, uses what is called the 'supplantation method' (Salomon, 1970). Salomon believed that individuals cannot have all the skills necessary to carry out various tasks. A learner will perform a task successfully if the method of instruction provides the function required by a learning task that the individual does not possess. Supplantation (Salomon, 1970) is a method which intends to bridge gaps in the learner/task link so that individuals with the haptic perceptual mode, for example, could perform better if given the opposite form of instruction (visual) when presented with a visual task.

The Matching Approach

Researchers focusing on matching instructional method to the perceptual mode of the individual agree with Hess and Sperry's (1973) application of cognitive style to

training. Hess and Sperry assert that the trainer should first assess the perceptual mode of his/her learners and then plan the instruction based on the dominant modality of the particular group. For example, if one's members are visual types, the trainer should use charts, diagrams, and reading selections. For haptic learners, the format should be more physically-oriented (e.g., role-playing).

Taking an individual's level of reflexivity/impulsivity and analytic/global thinking into account can help the trainer understand trainee's responses to various training techniques (Hess & Sperry, 1973). Global thinkers can become frustrated by detailed step-by-step programmed instruction. Impulsive learners might blurt out answers while reflective thinkers require more time to respond to situations. This will aid a trainer's awareness that everyone works at different speeds.

Hess and Sperry (1973) claim that differences between field independent/dependent people is exhibited in group discussions. Field dependent people are more gregarious, answer and ask factual questions and accept an individual's word with little question. The field independent person is more analytic, will ask 'why' questions more often and will challenge another person's opinion more readily.

Mezoff (1982) focused predominantly on field independence/dependence and developed a conceptual framework for a matching model approach to human relations training research. He hypothesized how persons of

different cognitive styles will be differentially responsive to structured (e.g., role plays, simulation games) and unstructured (e.g., T-groups) human relations training (Wexley, 1984).

Kolb and his associates (Kolb, Rubin, & McIntyre, 1979) have advocated the use of his learning style inventory in addition to other information about the individual's cognitive style to assess what training methods one would use with various cognitive styles.

The Supplantation Method

In contrast to matching cognitive style with a method of instruction, F.B. Ausburn (1979) discussed the current focus on the interactive research heuristic in which the characteristics of tasks, learners, and instructional media are examined together in order to locate instances in which specific learners are aided in performing specific tasks by specific instructional treatments. L.J. Ausburn (1976) found that there is a relationship between how an individual acquires and processes information, and his or her performance on some learning tasks. Some cognitive styles interact unfavorably with the psychological requirements of some tasks and thus result in poor performance by the learner. Researchers advocating this approach believe that since cognitive style is a stable characteristic, instruction should be designed and altered to minimize gaps in the links between learner capabilities and task requirements.

F.B. Ausburn (1979) used the supplantation method in a study which analyzed haptics and visuals' performance on a visual task. Two types of visual methods of instruction were used: a linear-image, where one picture was seen at a time on a screen and multiple-image where several pictures could be seen simultaneously. Students had to identify one item from a group of pictures. Visuals always performed superior to haptics, yet when haptics were given the multiple-image treatment, the difference between the visuals and haptics' performance was significantly lower than when a linear-method was used.

Purpose and Hypotheses

The purposes of this experiment were as follows:

1. The relationship between dimensions of cognitive style and perceptual mode as well as their association with a learning style instrument were examined in the first half of the study. The relationship between field independence/dependence and Type A behavior was also explored;

2. During the second half of the study, trainability as a match between perceptual mode and instructional method was investigated.

The research suggests that visuals tend to exhibit field independent behaviors, reflectivity and sharpening in their cognitive styles, while haptics tend to display field dependence, impulsivity and leveling tendencies. All subjects were tested on these dimensions as well as one addressing mental ability. It is not yet certain whether

perceptual mode is a cognitive or physiological style dimension. Perceptual mode was reexamined in this study. Since the Kolb LSI appears to measure cognitive style dimensions, there should be some relationship between other measures of cognitive style and the dimensions of the Kolb LSI. It seems possible that the Kolb LSI addresses measures of cognitive style (e.g., reflectivity/impulsivity) not learning style, however there are no definitive conclusions about this. This study explored this issue. Finally, Type A behavior and field dependence/independence seem to share similarities as well as discrepancies. The relationship between them was explored here.

The following hypotheses for the first half of the study were formed based on the literature reviewed.

H_1: Individuals who are visual exhibit field independent behaviors, reflectivity, sharpening and higher mental ability while haptics display field dependent behaviors, impulsivity, leveling and lower mental ability in comparison to visuals.

H_2: The **Active Experimentation** dimension ("doing") of the Kolb LSI correlates with dimensions of the haptic-cognitive style while the **Reflective Observation** dimension ("watching") correlates with the visual-cognitive style.

H_3: Type A individuals exhibit more field dependent behaviors while Type Bs exhibit more field independent behaviors.

During the second half of the study trainability was studied as a match between perceptual mode and instructional method. The research suggests that matching instructional methods to perceptual mode (e.g., visual) facilitates learning. The specific hypothesis for the second half of the study is as follows.

H_4: Visuals and haptics, who are matched with their optimal instructional method perform superior to other situations where their perceptual mode is in contrast to the instructional method used.

Method

Overview

This experiment was ostensibly designed to assess subjects' personalities and performance when completing a task (i.e., origami). One hundred and twenty subjects filled out a battery of instruments to assess dimensions of their cognitive style and personality. Eighty-one of the subjects who completed the instruments and also indicated they had never folded origami before, watched the experimenter fold three objects. After the experimenter folded each object, the subject folded the same one using either a visual or haptic method of instruction. The subject used each method of instruction only once. After the experimenter folded the third object, the subject was asked which method of instruction he/she preferred. The subject did not fold the third object. The subjects were thoroughly debriefed and thanked.

Subjects

Eighty college students from Tulane University, as well as forty young professionals from major corporations in New York participated in this study. The students received extra credit for their participation; the young professionals were volunteers. The subjects ranged in age from 17 to 31 years (mean age=20.9). There were 54 males and 66 females.

Instruments

Measures were used to assess: (1) perceptual mode, (2) dimensions of cognitive style (field independence/dependence, impulsivity/reflectivity, and leveling/sharpening), (3) mental ability, (4) Type A behavior, and (5) performance on a learning style inventory.

The first set of measures used assess an individual's perceptual mode. Lowenfeld's Visual Haptic Word Association Test (Lowenfeld, 1945) is composed of 20 words, each of which elicits visual and haptic responses equally well. The subject is given a list of words and asked to write down the first association which comes to mind. A visual response is defined as an association, such as 'climb/mountain' in which a visual object is given as the association. A haptic response is defined as an association, such as 'climb/difficult', in which a muscular, physical, kinesthetic, or emotional word is given as the association. Neutral words are those which cannot be classified as either visual or haptic. For example, a

subject's response of 'hello' to the stimulus word 'greeting', might be considered a neutral response.

Perceptual mode was also assessed with Lowenfeld's Test of Subjective Impressions. The test is a simple drawing task in which the subject is asked to draw two things: a table with a drinking glass on top of it, and a table with a chessboard on top. Unlike the Word Association Test which accounts for visual, haptic and neutral responses, the table test accounts for only those that are visual or haptic. Visuals draw the table from an objective view, which does not change according to its meaning. The table will always be drawn with a top and legs if one is visually minded (proper perspective). Haptics' drawings are more subjective. He/she draws the glass or chessboard in accordance with his/her tactile impression. The figures are drawn from the plan, elevation, or side view.

Witkin's Group Embedded Figures Test (GEFT) (Witkin, 1971) was used to measure field independence/dependence. The GEFT is confined to measuring the trait of field independence in terms of ability to overcome the embedding context of a visual field by locating a simple geometric figure within a complex one. The GEFT contains three sections. The first section, which contains seven very simple items is primarily for practice. The second and third sections contain nine more-difficult items. The score is the total number of simple forms correctly traced in the second and third sections. Higher scores indicate

field independence. The GEFT rather than the Embedded Figures Test (EFT) was used to save administration time due to the volume of tests used in this study.

The Wonderlic Personnel Test (WPT), Form II, (1939-1983) was used to measure general mental ability. It provides a quick estimate of individual adult intelligence. While it measures the ability, it does not measure the extent to which a person will employ their ability. The Wonderlic is a 50 item, 12 minute test. Higher scores are affiliated with greater mental ability.

The 1985 version of the Kolb Learning Style Inventory (Kolb, 1985) was used to attain a measure of learning style. The Kolb LSI is composed of 12 sentences. The subject rank orders the four endings of each sentence, "4" being the most like them down to a "1" meaning the least like them. The responses are aligned in columns so that the sum of each column represents a different dimension of Kolb's LSI.

Reflectivity/impulsivity was measured with the adult form of Kagan's (1969) Matching Familiar Figures Test (MFFT). It is consistently used as the basic index of the trait. In the MFFT, the subject must examine a standard in the form of a black-and-white line drawing of a figure (such as a lion, bed or a flower) and then look at a group of similar variants and select the one which is identical to the standard. The standard and all variants remain in the subject's view at all times, thus eliminating memory as a variable. The adult form of the MFFT consists of 12

items with eight variants per item. The dependent measures for the test are mean response latency and mean number of errors per item. A longer latency and fewer errors are associated with more reflective behavior while a shorter latency with many errors is affiliated with impulsive behavior.

Leveling/sharpening was assessed with Santostefano's (1971) Leveling-Sharpening House Test (LSHT). The LSHT is one of several tests included in Santostefano's Cognitive Control Battery (CCB). The test battery measures discrete, nonverbal cognitive functions that play a role in learning and adaptation. The tests are designed for children and adolescents but the LSHT can be used for adults as well. The LSHT consists of 60 black line drawings of a scene containing a two-story house with windows, a door, a weather-vane, a chimney, a side walk, a fence, a cloud, a tree and a sun. The intact picture is displayed three times. Then one element is omitted and the picture is again shown three times. An additional item element is omitted every three trials until a total of 19 elements are omitted from the original display, with the least conspicuous element eliminated first, and the most obvious last. The subject is asked to tell the examiner when something looks different form the previous picture. The dependent measures are: the number of the card where the first correct change was noticed; the number of correct changes reported; and a leveling-sharpening ratio. Incorrect changes (e.g., the house is moving) can also be

recorded. Earlier detections of first correct change reported, greater numbers of correct changes detected and lower ratio scores reflect cognitive sharpening. Conversely, later detections of the first correct change, fewer numbers of correct changes perceived and larger ratios indicate cognitive leveling.

Two forms of the Jenkin's Activity Survey (JAS) (Jenkins, Zyanski and Rosenmen, 1979) were used to assess Type A behavior. Young professionals in New York filled out Form C and College students in New Orleans filled out Form T. The items are identical except where one form asks questions pertaining to school, the other asks questions regarding ones employment. The instrument consists of 21 items; Type A behavior is represented by higher scores.

Procedure

Undergraduate students at Tulane University in New Orleans taking Introductory Psychology were asked to participate in this research in exchange for extra credit toward their grades. Young professionals from various companies in New York were recruited in exchange for feedback about themselves on the tests administered. Data in New Orleans was collected by an senior undergraduate while the author of this research collected data in New York. Research laboratories were set up both in New Orleans and New York and instructions were written to assure consistency across administrations.

Upon arrival at the lab, each subject was told that the first half of the study was designed to measure aspects

of his/her personality. The subjects were also lead to believe that some of them would be asked to complete a task to determine how people with their personality perform on a given task.

All participants were given the following battery of measures. Subjects first filled out two measures that assessed perceptual mode: Lowenfeld's Visual Haptic Word Association Test and Lowenfeld's Tests of Subjective Impressions (Lowenfeld, 1945). Subsequently the participants filled out the Group Embedded Figures Test (GEFT), Wonderlic Personnel Test (WPT), the Kolb Learning Style Inventory (Kolb LSI), and Jenkin's Activity Survey (JAS). The experimenter then administered both the Matching Familiar Figures Test (MFFT), and the Leveling/Sharpening House Test (LSHT) according to the test author's standardized instructions. All subjects also filled out a page (see Appendix A) which asked for the following demographic information: sex, age and whether or not he/she had ever made origami (Japanese folding art) before. Subjects indicating no prior experience with origami were asked to stay and fold some origami objects with the instructor. All other subjects were thanked for their participation and thoroughly debriefed.

The origami phase consisted of three phases. During the first two, the experimenter demonstrated how to fold a specific object. Subsequently, the subject folded the same object with the help of one of two methods of instruction. Performance was measured by the amount of time the subject

took to perform the task, and the quality of the object. During the third phase, the experimenter demonstrated how to fold an object and then asked which method of instruction the subject would prefer to use to learn how to make it. The subject did not actually fold the object the third time.

Three origami objects were selected based on level of difficulty and the number of steps involved. The objects chosen were: a pigeon, a Japanese helmet, and a cicada. The author believed the objects were of equal difficulty due to the number and type of folds required.

The two types of instructions (visual/haptic) provide the subject with the same information. The difference between them is the medium used to transmit the information. When in the visual condition, individuals were provided with a two-page document containing step-by-step diagrams and simple written instructions on how to fold the object (see Appendices B,C,& D). Individuals in this condition could look at the object at a distance but not touch it. Individuals in the haptic condition were given a completely folded object. They were not given any form of written instruction. Instead, they were told they could work with the object in any way they cared to. They were encouraged to unfold the object slowly and then to refold it in order to learn how to make it. Extra pre-made objects were kept for the subjects in case the subject had taken the model apart but could not fold it back together again.

At the beginning of the session, the experimenter said to the subject:

> "Now I am going to ask you to make an object out of paper. You probably know that this is called origami. I will first fold the object for you. During that time, I must ask you not to ask any questions... just watch carefully. When I am finished, you can make it."

Subjects had been grouped into one of four order conditions upon entering the lab. The order conditions were based on two dimensions: type of object made, and type of instructions used. The cicada was always the final object made. The four orders were:

	OBJECT#1	METHOD#1	OBJECT#2	METHOD#2	OBJECT#3
1.	Pigeon	Visual	Helmet	Haptic	Cicada
2.	Pigeon	Haptic	Helmet	Visual	Cicada
3.	Helmet	Visual	Pigeon	Haptic	Cicada
4.	Helmet	Haptic	Pigeon	Visual	Cicada

If the first method was **visual**, the subject was told:

> "O.K., I would now like you to fold the same object that I just made. I will put the (name of object) that I just made over here. You can look at it but not touch it. But here are instructions and paper you can use to make it."

The subject was then handed a piece of paper and the instructions. The experimenter first did a brief demonstration about how to read the instructions. The subject was then told to begin.

If the first method was **haptic**, the subject was told:

> "I would now like you to fold the same object that I just made. Here is a piece of paper to fold the object. You can also use the one I just made to determine how to fold it. I suggest that

you unfold the object slowly, one fold at a time, and then refold it. OK. begin."

Then, the experimenter said:

"Great, now I will show you how to fold another object. Again, please don't ask any questions while I make it, just watch carefully."

The experimenter folded the second object.

If the second method was **visual**, the experimenter said:

"This time, you can use these instructions to fold the object but you can't touch the one I made. Here is a piece of paper, please begin."

The experimenter did the same demonstration regarding how to read instructions that was discussed above.

If the second method was **haptic**, the experimenter said:

"This time I will not be giving you instructions but I will give you the one I made before. I suggest that you slowly unfold it and refold it to learn how to make it. Here is a piece of paper,...please begin."

Then, the experimenter said:

"O.K., this will be the last one we will make. Again, I will fold it first and then have you do it. Please don't say anything while I make it. Watch carefully."

The experimenter folded the third object and then said:

"I would now like you to fold it. Would you prefer using the written instructions or the object I just folded?"

The object and the instructions were left on the table in front of the subjects while they made their decisions. The subjects were asked why they chose the method they did and were then told that they did not have to fold the object. The subjects were thanked at this point and thoroughly debriefed.

Results

Subject Scores

Instruments in this study often yield more than one score per subject. To facilitate the interpretation of any analyses performed, combined scores were used where possible. Santostefano's Leveling Sharpening House Test produced five scores per subject. The five scores were factor analyzed using SAS's principal component analysis (PROC FACTOR) (SAS, 1985). The scree test was used to determine the number of factors to retain. A two factor solution resulted. The factor loadings can be seen in Table one.

The first card where a correct change was recognized (FIRST CORRECT CHANGE), the total number of changes noticed (TOTAL # CHANGES) and the leveling/sharpening ratio (LSHT RATIO) composed the first factor ("leveling/sharpening"). The reader will recall that earlier detections of the first correct change reported, greater numbers of correct changes detected and lower ratio scores reflect cognitive sharpening. Subjects' scores on these three variables were standardized and combined into one score (LSHT) with the following formula: .9(LSHT RATIO) - .9(TOTAL # CHANGES) + .8(FIRST CORRECT CHANGE/2). FIRST CORRECT CHANGE was divided in half since its standard deviation was twice that of the other two variables. Lower scores on LSHT indicate cognitive sharpening.

CHANGES-A and CHANGES-B loaded positively and equally on the second factor. Since both of these represent

Table 1

Factor Loadings of LSHT Scores

Two Factor Solution

	Factor 1	Factor 2
First Correct Change	.77	--
Total # Changes	-.92	--
LSHT Ratio	.96	--
Changes-A	--	.74
Changes-B	--	.75
Eigenvalues:	2.42	1.15

Note. Loadings less than ±.5 are not reported above.

incorrect changes reported (e.g., the house is moving), the subjects' scores on the two variables were added together to create one variable (INCORRECT CHANGES). A correlation matrix between all of the House Test variables was generated. The correlation between LSHT and INCORRECT CHANGES (r=.12) was not significant ($p < .19$); the two composite variables measure different constructs.

Perceptual mode was represented by one dichotomous variable on the Table Test (1=visual, 2=haptic) and three continuous variables on the Word Association Test. The Word Association Test reports the number of visual, haptic and neutral words. Since the hypotheses in this study focus strictly on visuals and haptics, one measure of visual/haptic perceptual mode was desired. The correlations between the three types of words were generated and can be seen in Table 2.

A high negative correlation existed between visual and haptic words, and haptic words were significantly correlated with neutral words. Visual words however did not correlate with neutral words. The number of visual words reported was used as one's visual/haptic score on the Word Association Test because it was not contaminated by any variance shared with neutral words. Higher numbers of visual words reported indicate more visual responses, whereas lower scores indicate those that are more haptic.

The experimenter expected that subjects' scores on the Table Test and the Word Association Test would be correlated since both measures purport to assess perceptual mode. The

Table 2

Word Association Test and Table Test Correlations

	Visual Words	Haptic Words	Neutral Words
Visual Words		-.91*	-.09
Haptic Words			-.28*
Table Test	-.03	.02	.07

Note. The Table Test provides a dichotomous score (visual=1, haptic=2)

*$p < .01$

correlations between the measures, as illustrated in Table 2, imply that no significant relationship between the measures emerged. Subjects' scores on the two tests were left separate in subsequent analyses since it appeared that they were measuring different things. The MFFT yields two continuous scores: latency and error. The scores were left separate because in previous research, the error component was related to field independence and perceptual mode but the latency component was not. Subjects' scores on the measures (e.g., field independence/dependence) were maintained as continuous variables to retain as much variance as possible. A complete list of the sample sizes, means and standard deviations of the measures used in this study is presented in Appendix E. Appendix F contains a complete list of the measures' range of scores and rules for interpretation.

Hypothesis 1

A correlation matrix of the variables involved in the first hypothesis (perceptual mode, field independence/dependence, reflexivity/impulsivity, leveling/sharpening and intelligence) was computed. The data from the correlation matrix was then factor analyzed using SAS's principal components analysis (PROC FACTOR) with a varimax rotation (SAS, 1985). The factor analysis was computed on the correlations, rather than the raw data to avoid loosing a complete set of data for one subject due to missing data on one measure.

The scree test which plots the eigenvalues, indicated that a three factor solution was optimal. Correlations of ± .5 were considered salient. The correlations between the cognitive dimensions as well as the factor loadings on each of the three factors are illustrated in Table 3 and Table 4 consecutively. From the correlation matrix, it is apparent that the subjects' scores on the Word Association Test (VISUAL WORDS) do not correlate with their scores on any of the other cognitive dimensions. The Table Test correlates only with the latency dimension of the MFFT. The factor structure indicated that the Word Association Test and Table Test load on their own factor separate from the other cognitive dimensions. It appears that not only is there no relationship between the two measures of perceptual mode but there is no connection between perceptual mode and the other cognitive dimensions as well.

Hypothesis 2 and 3

The purpose of the second hypothesis was to investigate the relationship between the haptic and visual cognitive styles with the Kolb LSI dimensions. Since no relationship between perceptual mode and the cognitive style dimensions emerged, a correlation matrix between each of the cognitive style dimensions, and the column totals of the learning style inventory was generated. Type A behavior was included in the analysis to investigate the relationship between field independence/dependence and Type A behavior (hypothesis 3). The correlations are listed in Table 5. The correlations indicate that there is no relationship

Table 3

Correlations Between Scores on Cognitive Measures

	GEFT	MFFT Lat.	MFFT Err	LSHT	Incorrect Changes	Visual Words	Table Test	Wonderlic
GEFT		.10	-.20*	-.30**	-.21*	-.08	.15	.35**
MFFT Latency			-.67**	-.11	-.27**	.01	.20*	.04
MFFT Errors				.15	.36**	-.15	-.11	-.09
LSHT					.12	-.05	-.02	-.23*
Incorrect Changes						-.03	-.06	-.10
Visual Words							-.03	-.05
Table Test								.09
Wonderlic								

**$p < .01$

*$p < .05$

Table 4

Factor Loadings of Cognitive Measures

3 Factor Solution - Hypothesis 1

	Factor 1	Factor 2	Factor 3
GEFT	--	.74	--
Wonderlic	--	.72	--
LSHT	--	-.68	--
MFFT Latency	-.86	--	--
MFFT Errors	.88	--	--
Incorrect Changes	.56	--	--
Visual Words	--	--	.74
Table Test	--	--	-.63
Eigenvalue:	2.15	1.40	1.00

Note. Loadings less than ±.5 are not presented above.

Table 5

Correlations Between Cognitive Style Dimensions, Kolb LSI Dimensions and Type A Behavior

	RO	AE	AC	CE	TYPE A/B
GEFT	.00	-.06	.03	.04	-.15
MFFT Latency	-.13	.06	.10	-.02	.06
MFFT Errors	.10	-.08	-.13	.11	-.07
LSHT	.02	.09	-.04	-.07	.02
Incorrect Changes	-.08	-.15	.11	.14	-.05
Visual Words	-.05	.13	.01	-.11	-.02
Table Test	-.05	.08	.01	-.04	.07
Wonderlic	-.13	-.06	.28*	-.08	-.02

*$p < .01$

between the LSI dimensions (RO or AE) and the cognitive style dimensions, or perceptual mode. Moreover, no relationship exists between field independence/dependence and Type A behavior.

Hypothesis 4

The researcher determined that a canonical correlation analysis should be used to analyze the data involved in the fourth hypothesis. Prior to completing the analysis, two MANOVAs were performed on the variables to be included. The independent variable in both analyses was "origami order". As previously stated in the method section, subjects were randomly assigned to one of four origami order conditions. The order was based on what object the subject folded first (pigeon or helmet) and what instructional method one received first (visual or haptic). The order conditions can be grouped into two sub-groups, one where visual instructions precede haptic and the other where haptic instructions precede visual (VH and HV).

The dependent variables in the first MANOVA were subjects' responses on the Word Association Test (# visual, # haptic, # neutral words) and the Table Test. The purpose of this analysis was to determine if any significant differences existed among the four cells (to check for random assignment of the subjects). The means across the cells for the four perceptual mode scores, as well as the means for the two sub-groups (VH and HV) can be seen in Table 6. There were no significant differences among the groups. The subjects were randomly assigned to the cells.

Table 6

Means on Four Perceptual Mode Variables Across Four Origami Order Conditions and Two Instruction Order Groups (Haptic/Visual (H/V) and Visual/Haptic (V/H))

	Origami Order				Instruction Order	
	PVCH	PHCV	CVPH	CHPV	HV	VH
Visual Words	8.0	8.7	10.5	10.0	9.4	9.2
Haptic Words	9.4	9.1	7.4	8.1	8.6	8.4
Neutral Words	2.6	2.2	2.1	1.8	2.0	2.4
Table Test	1.4	1.4	1.3	1.4	1.4	1.4

Note. Origami Orders are composed of two object types and two instructional methods. The first and third letters in the origami order is the object type (P=Pigeon, C=Cap (Helmet)). The second and fourth letter refers to the method of instruction (V=Visual, H=Haptic).

A second MANOVA was conducted to analyze the effects due to order, practice and difficulty level of the object. The five dependent variables were: object quality and latency when the method of instruction was haptic, object quality and latency when instructions were visual, and subject's preference for method of instruction (1=haptic, 2=visual). The means for the scores across each one of the origami order conditions, object type (pigeon/helmet) and order of instruction (HV or VH) can be seen in Table 7. Haptic quality was statistically significant across the cells $F(3,75)=2.94$, $p<.04$). Subsequently, a Neumann Keuls range test was generated with SAS's PROC ANOVA (SAS, 1985). The results suggest that the second and fourth order were significantly different from one another. The second order presents the pigeon first with haptic instructions and the fourth order presents the helmet first with the haptic instructions. The quality of the helmet is significantly better than the pigeon when the first method of instruction is haptic. There were no significant differences across the order conditions for visual latency: $F(3,75)=1.96$, $p<.13$; haptic latency: $F(3,75)=.49$, $p<.69$; visual quality: $F(3,75)=1.95$, $p<.12$; or choice: $F(3,75)=.39$, $p<.39$. Random assignment therefore did not lead to any systematic differences for visual/haptic latency, visual quality or choice across the cells.

A correlation matrix between all of the performance measures and perceptual mode variables involved in the canonical correlation was checked for risks of

Table 7

Means On Five Origami Performance Measures Across Origami Order, Object Type and Instruction Order

	Origami Order				Object Type		Instruction Order	
	PVCH	PHCV	CVPH	CHPV	Pigeon	Helmet	HV	VH
Haptic Quality	2.4	1.9	2.1	2.7	2.0	2.5	2.3	2.2
Visual Quality	1.8	2.4	2.1	2.4	2.1	2.2	5.0	5.2
Haptic Latency	5.1	5.0	5.2	5.0	5.1	5.0	5.0	5.2
Visual Latency	5.4	5.0	5.2	5.2	5.3	5.1	5.1	5.3
Choice	1.2	1.2	1.1	1.2				

Note. Origami orders are composed of two object types and two instructional methods. The first and third letters in the origami order is the object type (P=Pigeon, C=Cap (Helmet)). The second and fourth letter refers to the method of instruction (V=Visual, H=Haptic).

multicollinearity. The only significant correlations that emerged were: visual quality and visual latency (r=.37, $p<$ .008); and visual latency and haptic latency (r=.24, $p<$ .03). Mulitcollinearity was not a concern since the correlations were very low. A complete list of the correlations between each of the performance measures with the other variables in this study is presented in Appendix G.

A canonical correlation analysis using SAS's PROC CANCORR (SAS, 1985) was then performed between the set of perceptual mode and performance variables. The perceptual mode variables included: number of visual words on the Word Association Test (higher numbers reflecting more visual modes and lower ones representing more haptic modes), and the subjects score on the Table Test (1=visual, 2=haptic). Performance variables on the origami task included are the five presented above. A lower score on the latency variables indicate quicker performing and higher scores on the quality ratings indicate better quality. The choice variable was a dichotomous variable as stated above. A "1" suggests the subject preferred using the object to learn how to fold the object (haptic) and a "2" implies that the subject preferred the written instruction (visual). The canonical correlation results were not significant.

Additional Analyses

The most important hypothesis in this study was the fourth one: maximizing trainability by matching one's cognitive style (through perceptual mode) to instructional

method. Since it was found that perceptual mode was not related to any of the cognitive variables described, an additional canonical correlation was performed. The new canonical correlation involved all of the cognitive variables (not perceptual mode) and the performance variables. The cognitive variables were: field independence/dependence (GEFT); latency and error components on the MFFT (MFFT LATENCY, and MFFT ERRORS, consecutively), leveling/sharpening (LSHT); the number of incorrect changes reported on the LSHT (INCORRECT CHANGES) and subjects' scores on the Wonderlic (WONDERLIC). The reader will recall that higher scores on the GEFT indicate field independence, higher scores on the latency component with fewer errors on the MFFT represent reflective behavior, lower scores on LSHT indicate sharpening; and higher scores on the Wonderlic represent higher mental ability. The performance dimensions are the same ones as those used in the first canonical correlation.

The first canonical correlation was .48 and was significant at $F(30,270)=1.91$, $p<.004$. The second one which was .47 was also significant $F(20,226.5)=1.86$, $p<.016$. The subsequent canonical correlations were not statistically significant. Analyses of the two pairs of canonical variates that accompany the first two canonical correlations appear in Table 8. Shown in the table are loadings between the variables and the canonical variates, canonical correlations, and p values. The first two

Table 8

Loadings and Canonical Correlations Between Cognitive Style and Performance Variables and Their Corresponding Canonical Variates

	First Canonical Variate	Second Canonical Variate
	Loadings	
Cognitive Variables		
GEFT	.20	.46
Wonderlic	.67	.05
LSHT	-.28	-.39
MFFT (LATENCY)	-.33	-.03
MFFT (ERRORS)	-.11	.46
Incorrect Changes	-.49	-.40
Performance Variables		
Visual Latency	-.60	.32
Visual Quality	.89	-.07
Haptic Latency	.01	.31
Haptic Quality	.13	.86
Choice	.12	-.22
Canonical Correlation	.48	.47
p value <	.004	.017

canonical correlations account for the significant linkages between the two sets of variables.

With a cutoff loading of .3 for interpretation, the variables relevant to the first canonical variate in the cognitive style dimensions were, in order of magnitude, WONDERLIC (.67), INCORRECT CHANGES (-.49), and MFFT LATENCY (-.33). Among the performance variables, VISUAL QUALITY (.89) and VISUAL LATENCY (-.60) were relevant to the canonical variate. When using visual instructions, subjects who take less time to make the object and tend to make a better one (quality), tend to be less reflective, smarter and make less incorrect errors on the LSHT.

The second canonical variate in the cognitive style set was composed of MFFT ERRORS (.46), GEFT (.46) and LSHT (-.39), while the corresponding canonical variates from the performance variables were HAPTIC QUALITY (.86), and VISUAL LATENCY (.32), and HAPTIC LATENCY (.31). It seems that those who do well (quality) on the object when using haptic instructions take longer to do it. Moreover, these subjects tend to make more errors on the MFFT, are more field independent, and more sharpening in cognitive style.

The results of subjects' scores on Kolb's Learning Style Inventory (1985 version) (Kolb, 1981, revised 1985) were factor analyzed to determine the construct validity of Kolb's two bimodal dimensions. BMDP (1987 version) was used to run a principal components analysis on the 48 items (4 responses for each of 12 questions). A 14 factor solution (eigenvalues greater than 1) emerged when the researcher did

not specify the number of factors to retain. To determine if support for Kolb's two dimensions existed, a two-factor solution, with a varimax rotation was acquired.

A factor loading of $\pm$ .5 was considered salient. The emergent factor structure did not support Kolb's two bimodal dimensions (AC-CE and AE-RO). Instead, Abstract Conceptualization (AC) items loaded positively and Active Experimentation (AE) items loaded negatively on factor one. Moreover, Reflective Observation (RO) items loaded positively on factor two while Concrete Experience (CE) loaded negatively. The two dimensions might be CE versus RO (feeling - watching) and AC versus AE (thinking - doing) rather than AC versus CE (thinking - felling) and AE versus RO (doing-watching). The sample size (N=120) is too small to determine whether the results are conclusive.

Discussion

The researcher of this study hypothesized that "visual" individuals tend to be field independent, reflective, and sharpeners in their cognitive style, and more intelligent while "haptics" tend to be field dependent, impulsive, levelers and less intelligent in comparison. It was also asserted that visuals would perform better on a training task when taught with visual instructions and haptics would excel with a hands-on method.

A learning style inventory, which Ferrell (1983) claimed assessed the cognitive domain of learning style, was analyzed with the cognitive style dimensions presented here. The researcher believed that if performance was at a maximum

when perceptual mode (visual/haptic) was equivalent to the method of instruction (visual/haptic); and perceptual mode correlated with dimensions of cognitive style; then researchers could begin asserting that trainability is maximized by matching one's cognitive style with a specific method of instruction. Furthermore, if the dimensions of the Kolb LSI correlated with the dimensions of cognitive style, then the instrument might be a cognitive style rather than a learning style measure. Finally, the LSI, as a cognitive measure could be used as a predictor of how trainable individuals would be in various situations. Although none of the hypotheses concerning perceptual mode were significant, some interesting relationships among the cognitive variables and trainability emerged.

The first hypothesis examined the relationship between perceptual mode and cognitive dimensions. The researcher's main concern surfaced when subject's scores on the Word Association Test and Table Test did not correlate with one another. The scores were therefore left separate in subsequent analyses. The results suggested that subject's scores on the visual/haptic (number of visual words) dimension of the Word Association Test did not correlate with any of the cognitive style dimensions. The reader is reminded that the Word Association Test provides three scores: number of visual, haptic and neutral words. Even though the visual and haptic words did not correlate with any of the cognitive dimensions, neutral words did. Neutral words correlated with the latency (MFFT LATENCY) (r=-.24, $p<$

.007) and the error (MFFT ERRORS) dimension (r=.20, p<.03) of the MFFT. Neutral words also correlated with the number of incorrect changes reported on the LSHT (INCORRECT • CHANGES) r=.19, p<.008. Therefore it appears that individuals who write more neutral words are more impulsive and tend to make more errors.

The complete list and sum of neutral words stated can be seen in Appendix H. Although neutral words were not used as a score in this study, a brief investigation of what perceptual mode was being tapped by them was desired. Some of Lowenfeld's twenty words inspired more neutral words than others (e.g., greeting, hearing, breathing, and thinking). Neutral responses often appear to be examples or types. For instance, the word "greeting" invoked the words: hello, hi and christmas. The responses were often things one can/cannot see or feel. For example, the word: "breathing", invoked the words: air and life. At other times, the responses concerned hearing. The word "hearing" invoked the words: music, sounds and noise. Yet some words did not invoke any neutral words at all (e.g., riding).

It was presented above that individuals who write more neutral words tend to be more impulsive and make more errors. It seems possible that these individuals might be more auditory in perceptual mode and therefore are more easily distracted by external cues. One of Kolb's bipolar dimensions is a watching/hearing dimension versus a feeling dimension. This might be a better explanation. It seems that a great deal of information is being ignored by

categorizing some individuals as neutral. The construct validity of the measure should be investigated.

The only cognitive dimension that the Table Test correlated with was the latency dimension of the MFFT (MFFT LATENCY). Even though the correlation is low, $r=.20$, ($p<.03$), the data from the Table Test suggest that more reflective individuals tend to be haptic. According to previous research, one would expect that visuals, not haptics are more reflective. These results did not agree with those of the Word Association Test; the results cannot be confirmed.

F.B. Ausburn (1979) asserted that the error but not the latency component on the MFFT was related to perceptual mode. Moreover, he believed that field independence was a good predictor of perceptual mode. The results of this study contradict those of Ausburn. There appears to be no relationship between field independence and perceptual mode. Moreover, the latency component, not the error component was related to the results on the Table Test and neither correlated with the visual/haptic dimension of the Word Association Test.

F.B. Ausburn (1979) used three tests to assess perceptual mode: two of which were the same as those used here. He also included a variation of one originally developed by Lowenfeld. Individuals who scored visual/haptic on all three measures were classified as such. The scoring procedures used here were the same as those used

by Ausburn. The construct validity of the perceptual mode instruments is questionable and must be investigated.

The correlation matrix of all the cognitive dimensions suggests that field independence is accompanied by intelligence and sharpening. Moreover, these individuals tend to make less errors on the MFFT and the LSHT. The correlation between the latency dimension of the MFFT and the GEFT was not statistically significant. Unlike Ausburn, this researcher cannot assert that field independence is correlated with more reflective behavior.

The factor analysis revealed an interesting relationship among the cognitive variables. The three factor solution yielded the following factors: 1-speed/error, 2-IQ/ability and 3-perceptual mode. The number of errors one made on both the MFFT and LSHT loaded positively on the first factor while the latency component of the MFFT loaded negatively, suggesting that the more impulsive (speedy) one was, the more errors one made. The GEFT and the Wonderlic loaded positively on the second factor while the LSHT loaded negatively. This certainly suggests that the smarter one is, the more field independent and sharp in cognitive style one is as well. The second factor seems to represent a mental ability factor. L.J. Ausburn (1979) felt that the LSHT might be more related to memory recall than perceptual abilities. Memory recall ability might be a subset of this mental ability factor.

The third factor seems to verify that lower responses on the Table Test and higher ones on the visual words,

support the visual/haptic dichotomy. Even though the correlations are in the right direction, they are not significant. They are not tapping the same construct.

The results of the analysis for the first hypothesis suggest that perceptual mode is unrelated to the dimensions of cognitive style. Moreover, it is suggested that cognitive style is composed of two subsets, an ability dimension which is related to intelligence and a speed/error dimension.

The second hypothesis investigated the relationship between Type A behavior and field independence/dependence. The research had suggested that Type A Behavior shared the characteristics of impatience, time-urgency, and task orientation with field independent people and yet, Type As seem to share the need to seek out external sources to simplify/evaluate one's own performance with the field dependent person. This issue was investigated to examine possible links between personality characteristics and dimensions of cognitive style. The correlation between field independence/dependence and Type A behavior (r=-.15) was not significant ($p<.11$) suggesting that there is little relationship between the two constructs.

The third hypothesis examined the relationship between two of the LSI dimensions (Reflective Observation and Active Experimentation) with each one of the cognitive style dimensions. It was believed that a high score on the Reflective Observation dimension would correlate positively with one's score on the MFFT (reflectivity/impulsivity) and

the visual scores on perceptual mode test. This LSI dimension is believed to be a "watching" dimension. Moreover, haptic responses on the perceptual mode measures should have correlated with the AE ("doing") dimension. None of the cognitive dimensions correlated with the LSI variables in question.

Further investigation of the correlations between the other two LSI dimensions (CE) Concrete Experience and (AC) Abstract Conceptualization and the cognitive variables revealed only one significant correlation. The AC dimension, which implies "acting on intellectual understanding of a situation" (learn by thinking) correlated positively (r=.28) with the Wonderlic.

Several questions emerged as a consequence of this analysis. Ferrell (1983) found that the factor analysis of the items in the Kolb LSI revealed a factor structure that was cognitive in nature compared to other learning style inventories. If the Kolb LSI was truly assessing the cognitive dimensions of learning style, one would expect that the cognitive measures should have correlated with it. None of the LSI dimensions correlated with any of the dimensions of cognitive style. The Wonderlic (mental ability) did however correlate with one of the LSI dimensions. This suggests that at least one dimension of the LSI is an ability dimension. Maybe the LSI is an ability test of some sort. Therefore, one can assert that the Kolb LSI is not measuring the cognitive style dimensions affiliated with learning style.

It is apparent that the most important part of this study investigated a possible method of maximizing trainability. The results of the first canonical correlation clearly illustrate that there are no links between perceptual mode variables and performance variables. Whether the results are due to poor construct validity of the perceptual mode measures is not certain. The second one however did reveal some interesting relationships. F.B. Ausburn (1979) had found that when completing a visual task, visuals tend to be more field independent, reflective, and sharp. Whereas haptics were more impulsive, field dependent and levelers. Since visual/haptic tendencies did not correlate with any of the cognitive dimensions, it was left out of the second canonical correlation analysis.

Significant linkages emerged as a result of the second canonical correlation analysis. Results suggest that good performance on a haptic task requires different cognitive style dimensions, depending upon which method of instruction is used. It appears that individuals who do the haptic task well using visual instructions, complete it very quickly. Moreover, these individuals are more intelligent, impulsive and make less incorrect errors. When using haptic instructions, those who take a longer time to fold the origami, make one that is of better quality. People who succeed in this category are field independent, sharpening in cognitive style and tend to make more impulsive errors. Therefore successful performance on a haptic task, when

using different methods of instruction, depends on whether or not one possesses various cognitive style dimensions.

The reader is reminded that haptic quality was significantly different among the cells. The quality of the helmet, when taught with haptic instruction (fourth order) was significantly better than the quality of pigeon produced with haptic instructions in the second order. In both cases, these were the first objects presented. It was determined that the helmet is easier to fold than the pigeon when using haptic instructions. Therefore, the differences across the cells might be due to the difficulty level of the object or instructions. The folds involved in making the helmet are flatter and simpler. The research previously conducted implied that haptics have a difficult time taking things apart and then resynthesizing them (mentally). Using haptic instructions might be more difficult to use when making the pigeon than the helmet because it is a more difficult object to reassemble both physically and mentally.

The researcher is concerned that there might have been a problem with how the origami phase was handled. As the reader will recall, the experimenter first demonstrated how to fold an origami object and then the subject was either given written instructions or the object as an aid when folding it himself. Once that object was folded again, the experimenter demonstrated an object but the subject was given the other method of instruction. After demonstrating the third object, the subject informed the experimenter of his/her preference for method of instruction. One will

recognize the confound in this phase. The folding of each object was demonstrated by the experimenter. The subject watched how to fold it. All subjects therefore received visual instructions first before using the visual or haptic instructions as an aid. It is no wonder that of those subjects who participated in this phase (N=81), only 15 individuals chose to use the visual instructions.

Another confound in this phase is that origami is probably more of a haptic task than a visual one. Even if the instructor did not demonstrate how to fold the object, individuals might still have chosen to use the object as an aid because origami is a haptic task. Type of task, rather than perceptual mode might direct one's choice.

Conclusions

The relationship between various cognitive variables and other ability and personality measures was explored. It was found that 1) perceptual mode was unrelated to dimensions of cognitive style; 2) cognitive style dimensions separated into two sub-groups: ability-intelligence; and speed/error; 3) within the ability-intelligence area, it was determined that individuals who tend to be field independent and sharpening in cognitive style are more intelligent than their counterparts; 4) in the speed/error grouping, impulsivity was accompanied by numerous errors on different measures; 5) field independent individuals do not make as many errors on the various instruments as field dependent persons; 6) reflectivity-impulsivity (time) was not related to any

variables involved in the ability group; 7) dimensions of the Kolb LSI were not related to perceptual mode; 8) mental ability, as measured by the Wonderlic was related to the Abstract Conceptualization dimension of the Kolb LSI; 9) the Kolb LSI probably does not assess the cognitive style dimensions which contribute to one's overall learning style; 10) type A behavior and field independence/dependence were not related to one another; 11) different cognitive style dimensions are necessary to successfully complete a haptic task when given different forms of instruction; 12) when using visual instructions, subjects who do well, work quickly and are more intelligent and are more impulsive; 13) individuals taught with a haptic method of instruction succeeded if they worked more slowly, were field independent, and made more errors if they responded immediately; 14) trainability can be maximized (on a haptic task) by matching different methods of instructions to dimensions of one's cognitive style, such as field independence/dependence, leveling/sharpening, mental ability and reflectivity/impulsivity.

Future Research

Future research should examine the following areas:

1) The construct validity of the perceptual mode measures should be assessed, specifically, the neutral words should be studied;

2) The relationship between perceptual mode with cognitive style and physiological style should be

determined. It is not yet clear, whether perceptual mode is more closely related to cognitive style or physiological style;

3) Type of task as well as method of instruction should be varied when researching how to maximize trainability;

4) The relationship between other cognitive style dimensions and trainability should be examined.

Organizations could save large sums of money if they were to include a trainability assessment in the selection process. This study began looking at dimensions that might be related to trainability. This researcher is not asserting that the cognitive dimensions discussed here are the only ones that we should consider when predicting trainability. These are purely exploratory at this point. Experimenters working in this research domain should examine the relationship between other dimensions and performance so that we could determine which ones have the greatest impact upon it. Eventually, a measure will be developed that will tap each of the most relevant constructs.

The reader is cautioned against the use of another measure included in this study, namely the Kolb LSI, for any employee assessment purposes. While the analyses performed on the Kolb LSI data were purely exploratory, the results suggest that any conclusions drawn from an individual's score on it might be misleading. Further investigation of the measure is necessary.

Appendix A

Personal Data Sheet

Name _____ Subj. #: ____

Phone Number: _____
(Day)

_____
(Night)

Sex: _____

Age: _____

Have you ever done origami (Japanese folding art) before?

_____ Yes

_____ No

...if you answered "yes", please specify when you you did it.

_____

_____

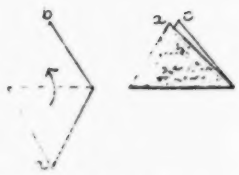
_____

Appendix B

Visual Instructions - Pigeon

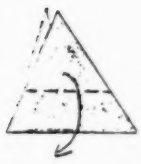
Pigeon

①



Fold a up to b.

②



Fold front and back flaps toward the front at dotted line.

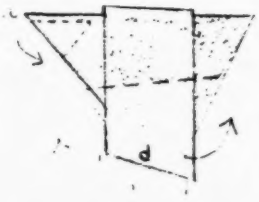
③

Fold back flap, backwards at dotted line.

④

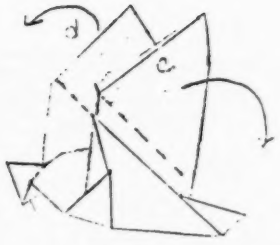
Fold d to c to set crease at dotted line.

⑤



Fold a down to set crease on dotted line.
Fold d upwards to crease at dotted line.
Fold c backwards to set same crease in reverse.

⑥

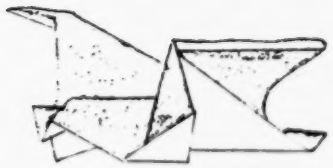


Fold d & c downward at dotted line to form wings.

Pigeon (continued)

(7)

It should look like this:



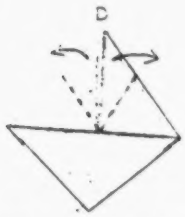
Appendix C

Visual Instructions - Helmet

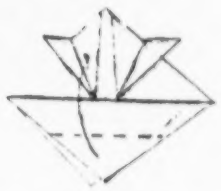
Japanese Helmet

Fold paper in half diagonally. Fold a & b to c.

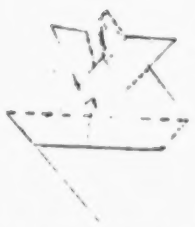
Fold front flaps at c up to d.



Fold flaps at d down to set creases as pictured.



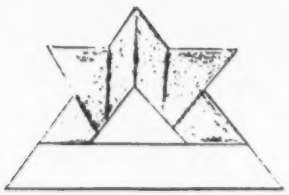
Fold up front flap (at c) and set fold at dotted line.



Fold front flap up & set fold at dotted line

Tuck back flap (at c) into hat.

Helmet (continued)



The helmet should look like this:

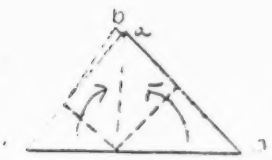
Appendix D

Visual Instructions - Cicada

Cicada

①

Fold a up to b and set fold at dotted line.

② 

Fold c & d in toward b.

③

Fold down flaps: a & b to set creases.

④

Turn down front flap at dotted line.

⑤

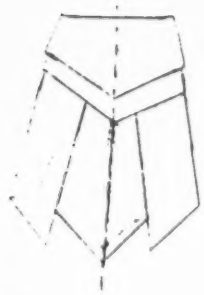
Turn down back flap at dotted line as pictured.

⑥

Crease object at dotted lines as pictured and turn sides backward.

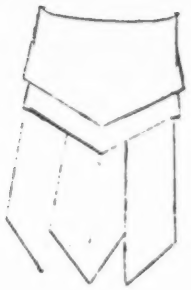
Cicada (continued)

(7)



Crease it in the middle
to make a curve

(8)



It should look like this!

Appendix E

Sample Sizes, Means and Standard Deviations

For All Measures

	Sample Size	Mean	Standard Deviation
GEFT	120	11.8	4.7
MFFT Latency	120	50.1	27.6
MFFT Errors	120	0.8	0.6
LSHT	120	0.0	2.0
Incorrect Changes	120	2.18	2.6
Visual Words	120	8.9	4.5
Haptic Words	120	8.6	4.8
Neutral Words	120	2.6	2.2
Table Test	120	1.4	0.5
Wonderlic	119	25.4	5.9
Reflective Observation (RO)	120	30.0	7.2
Abstract Conceptualization	120	33.5	6.6
Active Experimentation	120	30.4	6.8
Concrete Experience (CE)	120	26.1	6.3
Type A/B	120	8.2	3.4

	Sample Size	Mean	Standard Deviation
Haptic Quality	81	2.2	0.9
Haptic Latency	81	5.1	0.5
Visual Quality	81	2.1	0.9
Visual Latency	80	5.2	0.4
Choice	80	1.2	0.4

Appendix F

List of Measures: Their Score Ranges and Rules for Interpretation

Instruments	Score Range	Rules for Interpretation
GEFT (Field independence)	(1-18)	Higher scores indicate field independence
WONDERLIC (mental ability)	(1-50)	Higher scores indicate higher intelligence
TYPE A/B	(1-21)	Higher scores indicate Type A behavior
MFFT (reflectivity/ impulsivity)		A longer latency with fewer errors refers to reflective behavior. A shorter latency with many errors indicates impulsive behavior.
KOLB LSI:		
CE ("Feeling")	(12-48)	Higher scores on each dimension represents a greater amount of the characteristic in question.
RO ("Watching")	(12-48)	
AC ("Thinking")	(12-48)	
AE ("Doing")	(12-48)	
PERCEPTUAL MODE:		
TABLE TEST	(1-2)	1=Visual, 2=Haptic
VISUAL WORDS (WORD ASSOCIATION TEST)	(1-20)	Higher scores=Visual Lower scores=Haptic
HOUSE TEST:		
LSHT		Lower scores indicate sharpening.
INCORRECT CHANGES		Exploratory

ORIGAMI:

LATENCY	(0- ? SECONDS)	Shorter latencies represent quicker learning.
QUALITY	(0-3)	0=did nothing, 1=missed steps, 2=completed/sloppy 3=completed/good
CHOICE	(1-2)	1=Haptic, 2=Visual

Appendix G

Correlations of Cognitive, Personality, LSI Measures With Performance Measures

	Haptic Quality	Visual Quality	Haptic Latency	Visual Latency	Choice
GEFT	.29**	.14	-.14	.07	-.02
MFFT latency	.14	-.03	-.21	.05	.17
MFFT errors	-.03	-.17	.29**	.04	-.21
LSHT	-.17	-.08	-.07	.02	-.02
Incorrect Changes	-.32**	-.30**	.07	.03	-.06
Visual Words	.03	.13	-.11	.05	-.04
Haptic Words	.00	-.10	.10	-.08	.07
Neutral Words	-.07	-.07	.03	.08	-.07
Table Test	-.05	.13	-.00	.10	-.17
Wonderlic	.08	.26*	-.08	-.25*	-.07
Reflective Observ.	.14	-.03	-.07	-.05	-.11
Abstract Concept.	.04	.24*	-.01	-.01	-.07
Active Exper.	-.24*	-.04	-.06	-.06	.05
Concrete Experien.	.06	-.18	.16	.14	.15
Type A/B Behavior	-.12	.32**	-.15	-.32**	.11

**$p < .01$

*$p < .05$

Appendix H

Word Association Test - Neutral Words

(sum)	Stimulus Word:	Neutral Words Elicited:
(96)	GREETING	hello-77, hi-10, welcome-2 hola, christmas, greet, seasons, how, holidays, thank you
(9)	WALKING	exercise-3, movement, mile, hike, promenade, shine, stop
(5)	LOOKING	Easter, good, interesting, sight, Oh boy
(1)	CLIMBING	height
(10)	TALKING	speech-2, words, conversation, voice, bilingual, hi, language, gossip, communication
(14)	LIFTING	weight-8, strain, hernia, shut-up, exercise, time, air
(22)	THINKING	thought-6, headache-2, question, strain, about, psychology, mind, freedom, problem, trilingual, complex, time, doubts, concentration-2, ideas
(7)	DRAWING	skill-2, art, interesting, painting, intro-drawing, fine arts
(6)	CATCHING	cold-2, attractive, sports, touchdown, athletics
(34)	HEARING	music-11, sound(s)-8, noise(s)-5, voice-2, wind, things, stories, audio, loudness, news, loss, deafness
(6)	PULLING	tug-o-war-4, weight, strength
(9)	SWIMMING	lap(s)-6, exercise, competition, summer

(sum)	Stimulus Word:	Neutral Words Elicited:
(0)	RIDING	
(7)	RUNNING	exercise-2, race, sweat, miles, long distance, laps
(2)	JUMPING	jack, air
(18)	LISTENING	music-12, attention-2, comprehension-2, lecture, news
(1)	REACHING	connection
(1)	TOUCHING	ground
(16)	STRETCHING	exercise-7, aerobics-3, morning, loose, stretch, force, flexibility, pain
(35)	BREATHING	air-20, life-6, exercise-2, grasp, breath-2, respiration-2, rhythmn, anaerobic

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Biography

Pamela Ann Manfredo was born on July 29, 1963, in New York. She received a Bachelor of Arts, magna cum laude, from Washington University in St. Louis, Missouri in May, 1985. She was the recipient of the National Honor Society of Psychology's J.P. Guilford Research Award in 1985. After working for a year as a Project Director for a Market Research Company in New York, in 1986, she began graduate study in Industrial/Organizational Psychology in the Department of Psychology at Tulane University, New Orleans, Louisiana.